Observations on Habitat Selection and Partitioning by Brook Charr, *Salvelinus fontinalis* (Mitchill), in the South Duck River, a Manitoba Woodland Stream

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OBSERVATIONS ON HABITAT SELECTION AND PARTITIONING BY BROOK CHARR, Salvelinus fontinalis (MITCHILL), IN THE SOUTH DUCK RIVER, A MANITOBA WOODLAND STREAM

by

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ABSTRACT

Scherer, E., R.E. McNicol, and E.J. Murkin. 1984. Observations on habitat selection and partitioning by brook charr, Salvelinus fontinalis (Mitchill), in the South Duck River, a Manitoba woodland stream. Can. Manuscr. Rep. Fish. Aquat. Sci. 1788: iv + 8 p.

The South Duck River is a spring-fed woodland stream in west-central Manitoba (point of origin approx. 51°53'N, 100°42'W; max. altitude 600 m), containing a population of brook charr, Salvelinus fontinalis (Mitchill), but no other salmonid species. This report presents results of a preliminary survey on habitat selection and partitioning by this species within a 168 m long stream section, in relation to current velocity, substrate, and depth. A distinct separation of habitats for young-of-the-year and older year-classes was apparent. Young-of-the-year preferred shallow (≈10-20 cm deep), moderately fast-flowing (10-20 $cm \cdot s^{-1}$), gravel and rubble covered areas, while older year-classes were found in deeper areas (20-85 cm deep), with a wider range of current velocities and substrates, including areas covered with sand and silt.

Key words: lotic environment; habitat selection; microdistribution; current velocity; substrata; depth.

RESUME

Scherer, E., R.E. McNicol, and E.J. Murkin. 1984. Observations on habitat selection and partitioning by brook charr, Salvelinus fontinalis (Mitchill), in the South Duck River, a Manitoba woodland stream. Can. Manuscr. Rep. Fish. Aquat. Sci. 1788: iv + 8 p.

La rivière South Duck, alimentée par des sources, coule à travers les terres boisées du centre-ouest manitobain (point d'origine approximatif: 51°53' N, 100°42' O; altitude maximale: 600 m). Elle contient une population d'ombles de fontaine, Salvelinus fontinalis (Mitchill), mais aucun autre salmonidé. Ce rapport présente une recherche préliminaire sur la sélection de l'habitat et la répartition de cette espèce, dans une section de rivière longue de 168 m, en relation avec la vitesse du courant, la nature du lit de la rivière et la profondeur. Une très nette distinction entre les habitats des petites truites nées dans l'année et des poissons plus âgés est apparente. Les jeunes poissons préfèrent les eaux peu profondes (entre 10 et 20 cm de profondeur), où la vitesse du courant est modérée (entre 10 et 20 cm/sec.), et le sol recouvert de gravier et de rocaille, alors que les plus âgés se retrouvent dans des eaux plus profondes (entre 10 et 85 cm), où la vitesse du courant et le lit de la rivière changent beaucoup, incluant des endroits recouverts de sable et de vase.

Mots-clés: milieu lotique; sélection de l'habitat; microdistribution; vitesse du courant; nature du substrat; profondeur.

INTRODUCTION

This report is part of a study undertaken to document and analyse basic ecological characteristics of a Manitoba woodland stream as yet unstressed by chemical contamination or physical alterations (see Flannagan and Cobb 1983; McNicol et al., in press).

The South Duck River originates from the eastern escarpment of the Duck Mountain Provincial Park (center point approximately 51°30'N, 101°W), traversing an altitude from about 600-300 m. We selected a second-order stream section 168 m long, about 8 km from the source, containing a wide range of different microhabitats, for closer observation of brook charr distribution patterns in relation to abiotic factors. While a number of salmonid species have been repeatedly investigated under this viewpoint (the most recent study by Shirvell and Dungey 1983 focused on brown trout), information on brook charr is, by comparison, surprisingly scant.

METHODS

After exploratory observations, our studies were carried out during a short period (July 10-15, 1981) under rather stable conditions of flow, temperature, oxygen and pH. Flow velocities were measured with an OTT C31 Universal Current Meter, O_2 with a YSI Model 54 oxygen meter, and pH with a Radiometer Model PHM53 instrument. Noise and movements by observers were carefully kept at a low level; blinds were used to count and observe the more easily disturbed older year classes; the use of glare-reducing depolarizing glasses facilitated observation. Young-of-the-year (YOY) were easily distinguishable by size (not exceeding 50 mm) from older year-classes (>100 mm).

RESULTS

During the study period, dissolved oxygen ranged from 9.4-9.8 ppm, pH from 8.75-9.00, and temperature from 13.3-15.5°C. As Fig. 1C illustrates, the stream flowed through this 168 m long reach without major meanders or obstructions; accordingly, no longitudinal (nor transverse) gradients of temperature, oxygen or pH were found that could account for distribution patterns of brook charr within this section. Also, except for a sun-exposed stretch approximately 10 m up- and downstream from the road-crossing (i.e. including site 1), shading by riparian trees and dense brush was quite uniform. Three factors, however, varied greatly within the observation area and could therefore determine distribution patterns: current velocity, substrate, and depth. Table 1 summarizes and illustrates the variability of flow, substrate, and depth conditions observed at 8 m intervals.

A distinct distribution pattern with marked differences between young-of-the-year and older brook charr became apparent during the initial exploratory phase of our investigation. We selected six sites for closer observation of these two major population components, and for detailed recording of flow, depth and substrate conditions.

Those portions of sites 1 to 3 occupied by YOY (Fig. 2, Table 2) were characterized by moderately swift current (average ≈10-20 $cm \cdot s^{-1}$), limited depth (rarely exceeding 25 cm), and gravel to rubble substrate. While sites 2 and 3 were largely shaded, site 1 was fully exposed, with no obvious effect on fish density which averaged 1 to 4 per m^2.

Markedly different were the sites occupied by older year classes (Fig. 3). Greater depth (up to 85 cm) was the most consistent feature; current velocity ranged from around zero to about 85 $cm \cdot s^{-1}$; substrate varied from sand or deep-lying silt-covered rock to gravel, rubble, boulders or submerged tree roots and stems. Further, the distribution of adults within these sites was highly patchy and, during our study, also very predictable. There were three to four larger fish (≈15-25 cm length) per site, usually clustered in one or two specific spots at each site. At site 4, one such spot was in open water, while at sites 5 and 6 they were under and behind submerged tree trunks (Fig. 3). Site 6 contained a small area (≈1.5 m^2) that was shallow and gravel-covered, with current velocities around 20 $cm \cdot s^{-1}$ (similar in character to sites 1 to 3); we observed 2-5 YOY station-holding and feeding here. On the other hand, only once was an adult brook charr seen at sites 1 to 3, and it passed quickly through.

DISCUSSION

Over the past few decades, the term and concept "microhabitat" have become widely used to describe the specific location and associated combination of environmental conditions where different species or life stages occur within a larger habitat area. Recently, Shirvell and Dungey (1983) investigated the distribution of brown trout (Salmo trutta L.) within New Zealand rivers. Microhabitat selection was found to be mainly related to current velocity, depth and substrate. "Resident salmonids in streams habitually occupy only a small part of the entire habitat available to them..." is a conclusion drawn by Shirvell and Dungey (1983) after reviewing their own results and those of a number of previous authors (Wickham 1967; Baldes and Vincent 1969; Jenkins 1969; Chapman and Bjornn 1969; Lewis 1969; Everest and Chapman 1972; DeVore and White 1978); see also Keenleyside (1962), Symons and Heland (1978).

The study by Wickham (1967) is rather peculiar: he introduced an albino population of brook charr into a stream and found "a high spatial correlation with cover" (shading), as might be expected from fish lacking pigmentation of integument and eyes. While we were unable to investigate the possible influence of shading on adult brook charr in the South Duck River, this factor did not appear to affect the distribution of YOY (site 1 was fully sun-exposed, sites 2 and 3 were largely shaded).

In a number of studies on microdistribution, two or more salmonid species occurred sympatrically (Gibson 1966; Jenkins 1969; Bjornn 1971; Binns and Eiserman 1979; Griffith 1972; Fausch and White 1981; Cunjak and Green 1983), giving rise to the question whether the observed species-specific distribution patterns were the results of choice (preference) or interaction (competition) between closely related species. This complication of possible inter-salmonid interaction did not exist in the South Duck River with the brook charr as the only resident salmonid species; in fact, no other fish species was found in our reach of the river (a few kilometers downstream, slimy sculpin (Cottus cognatus), longnose (Rhinichthys cataractae) and blacknose (R. atratulus) dace occurred in moderate abundance; W. Franzin, Department of Fisheries and Oceans, Winnipeg, Manitoba, personal communication). However, the observed segregation of young-of-the-year from older year classes may reduce cannibalism and inter-cohort competition (Everest and Chapman 1972).

If preference for certain microhabitats (i.e. for particular subsets of environmental conditions) has adaptive significance with regard to survival and fitness of a species, the question arises as to which of its essential functions or activities is served by such an active selection or choice response. Different activities (e.g. feeding, territory maintenance, resting, spawning) may require different microhabitats. Scott and Crossman (1973) summarize data on spawning requirements. A thorough study of different life stages and activities in relation to subsets of stream habitat is still missing for the brook charr. We focused on young-of-the-year for a detailed, quantitative analysis of their activities at their chosen microhabitats. Continuous daytime recordings of YOY positions and activities at sites 1 to 3 showed that these fish spent 77% of time station-holding in positive-rheotactic orientation (i.e. mouth facing the current), allowing them to feed mainly on sub-surface drifting prey (83% of feeding time); 3% of total time was devoted to social interactions and territory defence. These results will be presented in a forthcoming publication (McNicol et al., in press).

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Table 1. South Duck River, surveyed stream section with 22 transects in 8 m intervals (0 = downstream end); W = width in cm; d_{max} = maximum depth in cm; V_{max} = maximum current velocity (approximate values, ±10%); s = substrate types listed in order of predominance. "Silt/sand" = less than ≈2.5 mm particle diameter; "gravel" = up to ≈25 mm; "rubble" = up to ≈100 mm; "boulders" = larger than ≈100 mm across.

Transect interval (m)	W	d_{max}	V_{max}	s	Transect interval (m)	W	d_{max}	V_{max}	s
0	420	6	60	gravel rubble	88	381	22	25	gravel rubble sand
8	460	85	5	sand silt	96	360	37	20	rubble gravel sand, silt
16	300	68	20	rubble gravel sand, silt	104	448	15	20	gravel sand silt
24	245	15	80	rubble gravel boulders	112	512	22	25	gravel sand silt
32	275	10	60	gravel rubble	120	340	20	70	rubble gravel sand
40	266	8	50	gravel rubble sand	128	407	17	90	boulders rubble gravel
48	323	17	80	gravel	136	452	23	40	rubble boulders gravel
56	279	12	40	gravel rubble	144	541	52	10	sand gravel
64	410	13	70	gravel rubble	152	331	32	80	boulders gravel
72	495	10	40	gravel rubble	160	226	17	70	boulders rubble gravel
80	423	36	30	rubble silt	168	388	48	20	boulders gravel rubble

Table 2. Transect measurements at sites 1 to 3 (see Fig. 2). Numbers under transects A to D denote stream widths in cm; M = measurement points across transects (see Fig. 2); d = depths in cm; v = velocities in cm/s.

	Site 1				Site 2				Site 3		
	M	d	v		M	d	v		M	d	v
A	1	27.0	5.0	A	1	24.0	16.9	A	1	36.0	8.6
388	2	41.5	8.6	385	2	21.0	13.4	322	2	20.5	12.6
	3	32.5	12.3		3	13.5	8.0		3	11.0	18.0
B	1	25.0	8.3	B	1	23.0	12.9	B	1	17.0	9.4
368	2	27.0	15.2	410	2	20.5	12.0	420	2	19.5	14.0
	3	22.0	10.6		3	16.0	9.0		3	18.0	22.6
C	1	12.0	13.4	C	1	17.5	14.6	C	1	10.0	25.8
382	2	23.5	14.3	410	2	18.5	14.0	330	2	16.0	12.6
	3	18.5	12.9		3	11.5	11.1		3	15.0	18.9
				D	1	15.5	18.6	D	1	16.5	39.8
				392	2	14.0	18.4	256	2	12.5	19.8
					3	9.5	15.4				
Range		12.0-41.5	5.0-15.2			9.5-24.0	8.0-18.6			10.0-36.0	8.6-39.8
Mean		25.4	11.2			17.0	13.7			17.5	18.4

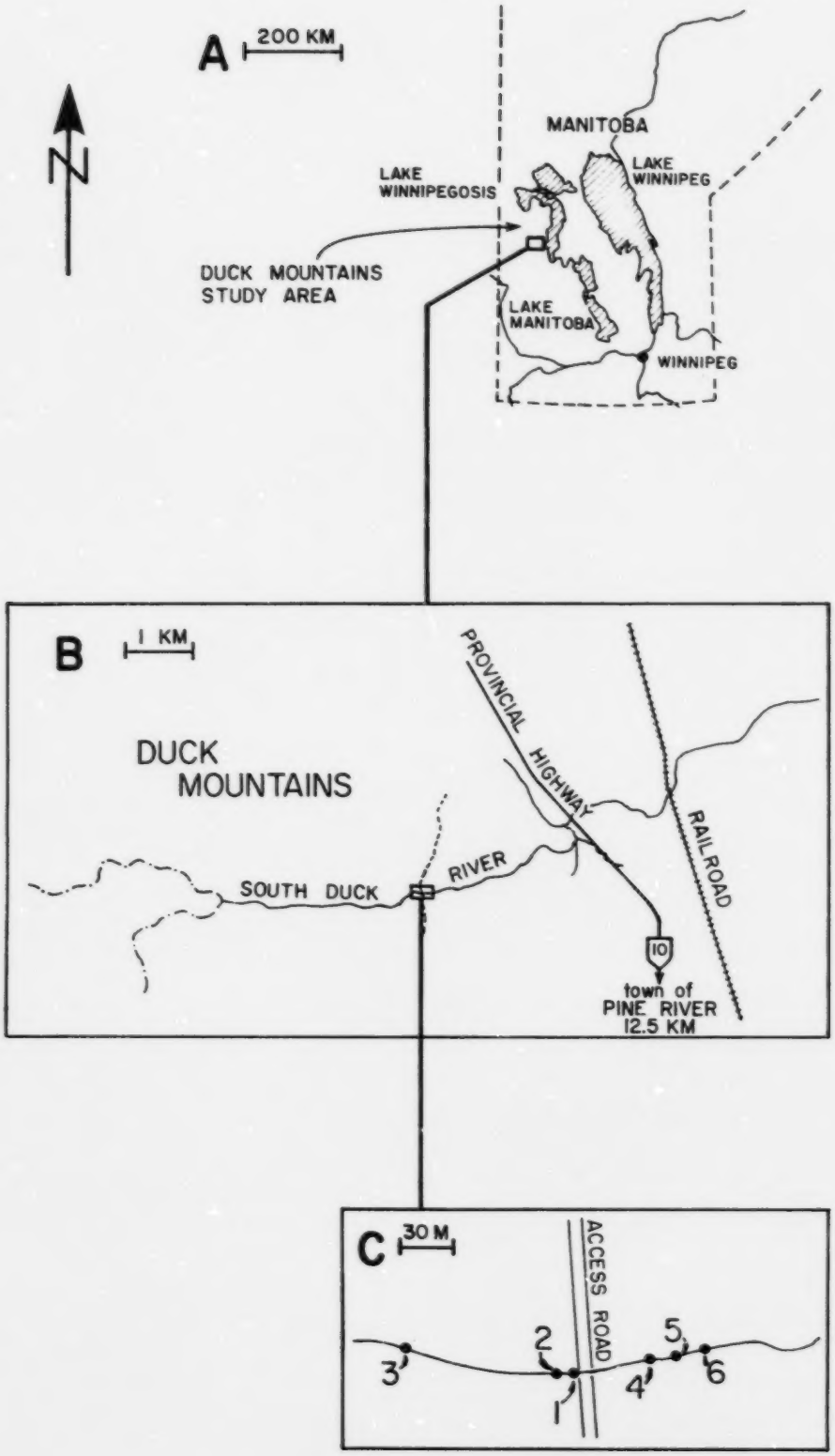

Fig. 1. Study area in west-central Manitoba (A) with South Duck River (B) and study sites 1-6 (C).

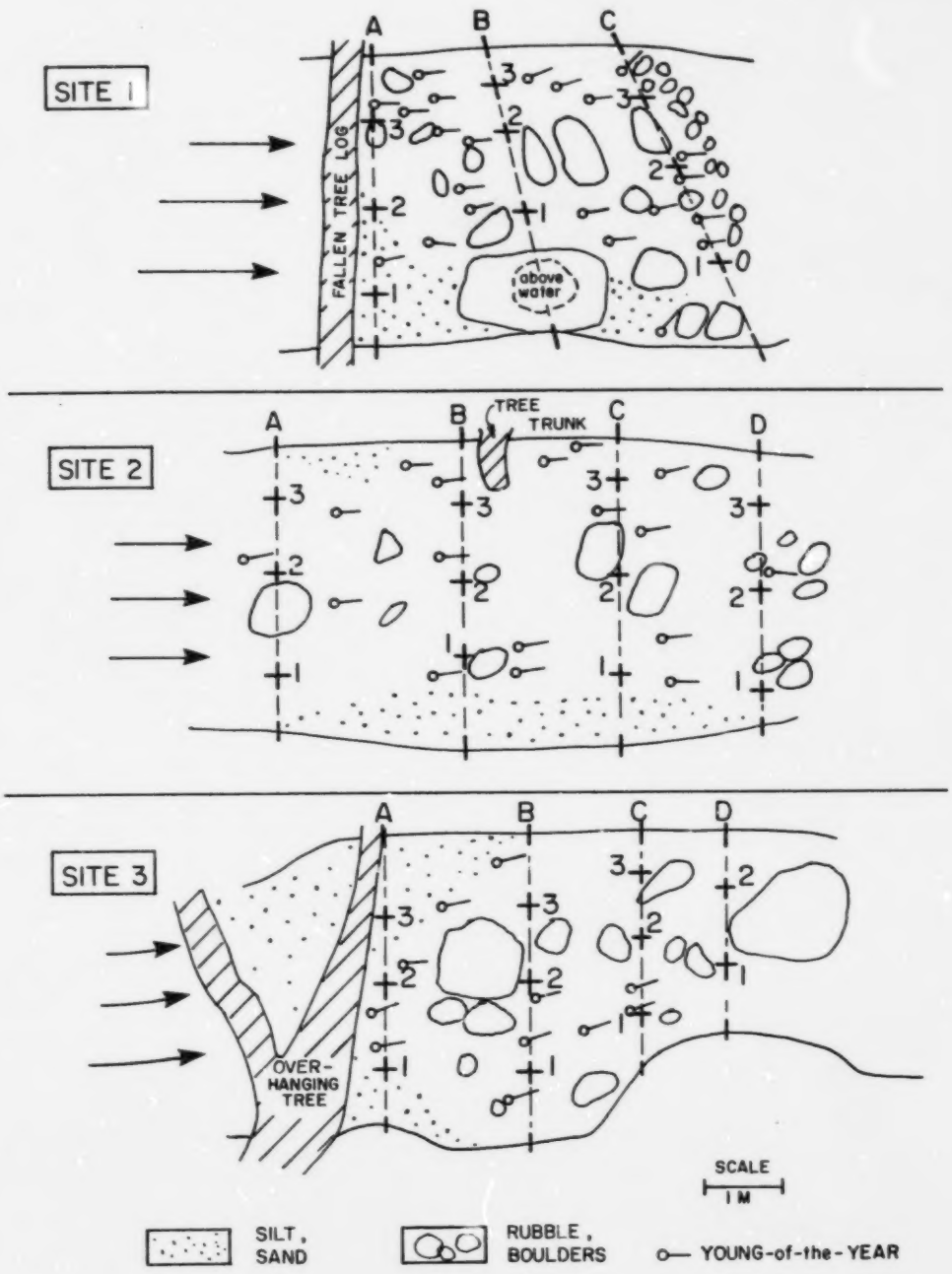

Fig. 2. South Duck River, sites 1-3 with transects, measurement points, and young-of-the-year position recordings (fish size not to scale). Arrows denote direction of stream flow. Only silt/sand and rubble/boulders are indicated, where predominant; areas between contained mainly gravel.

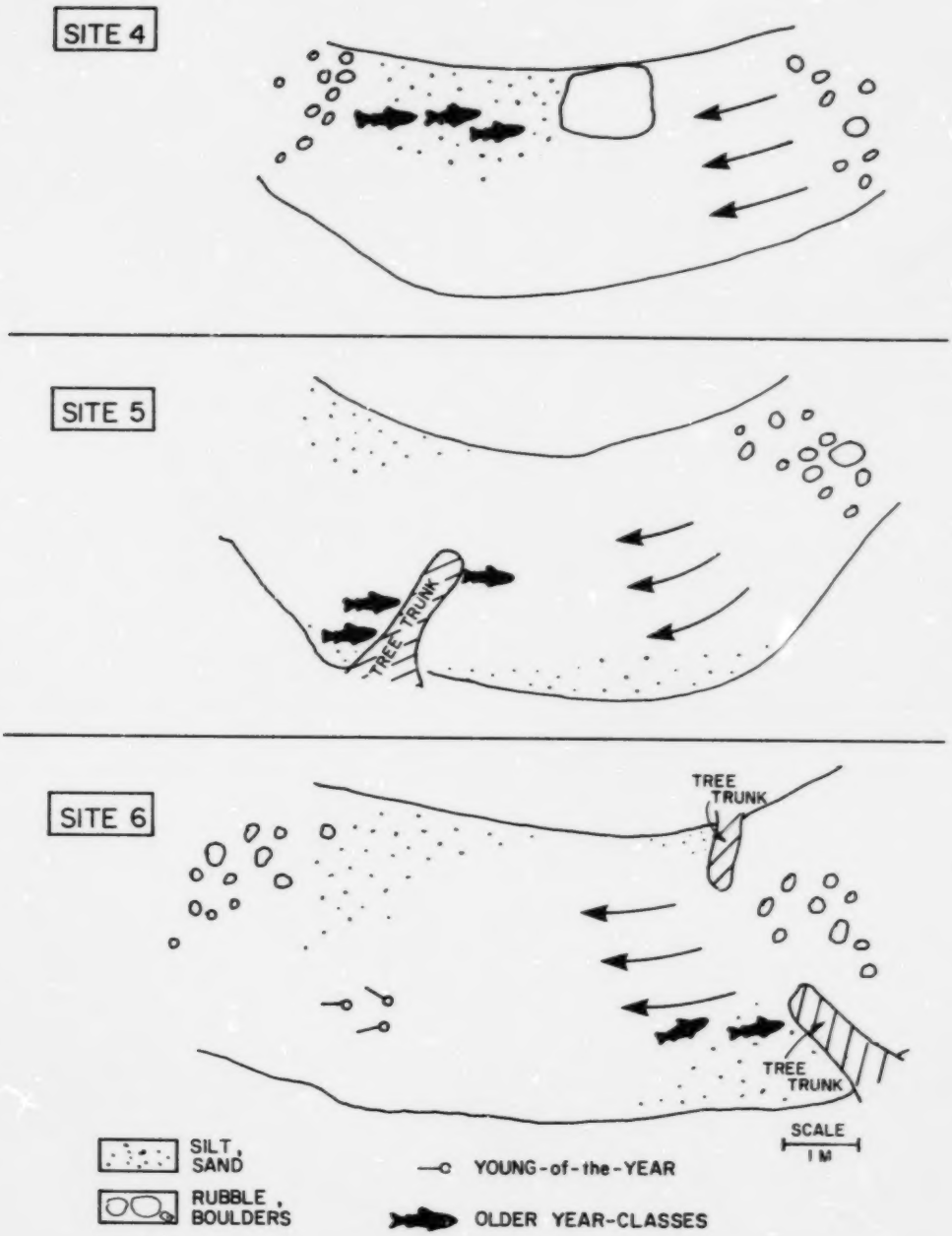

Fig. 3. South Duck River, sites 4-6 with recordings of fish positions (fish size not to scale). Arrows denote direction of stream flow. Only silt/sand and rubble/boulders are indicated, where predominant; areas between contained mainly gravel.

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